objections, and the investigations now recorded tend to show (1) that the seams are not all similarly anthracitic, and though each seam is generally more anthracitic than the one above it, there are many exceptions to the rule; (2) that the anthracitic character was not due to faults, but existed before the faults were formed; (3) that the anthracite existed as such before the coalfield was reduced by denudation to its present dimensions; and (4) that the percentage of ash diminishes *pari passu* with the decrease of bituminous matter. These conclusions point to the variations in the composition of the coals having been either original or at least of very early date. Indeed, of all the suggested causes of alteration subsequent to deposition, none appear to have been adequate to produce more than a slight modification of the differences due to original composition.

Written in faultless literary style and edited with scrupulous accuracy, this valuable addition to geological literature will appeal to a wide circle of readers, and the authors deserve great credit for the success they have achieved in the first attempt to define the distribution of anthracite and to explain its origin on purely experimental grounds.

VITALISM.

Versuch einer Begründung der Deszendenztheorie. By Prof. Karl Camillo Schneider. Pp. viii + 132. (Jena: G. Fischer, 1908.) Price 3 marks.

A COUPLE of years ago Prof. K. C. Schneider published six admirably clear and objective lectures as an introduction to the study of the evolution-theory. It was a useful exposition of the facts of variation and heredity, and of the Darwinian and Lamarckian interpretations. The present volume is critical and personal, and is not easy reading. We cannot do more than indicate the author's point of view. The first half of the book deals with stimulus, psyche and consciousness, subject and individuation, sensation and heredity, need and purpose, and Darwinism. The second half deals with mutation, potency, and structure; orthogenesis and extinction; trophic stimulus; vitality; entelechy and heritability; phylogeny, and the becoming of man.

The author's general position is closely akin to the positivism of Mach and Avenarius, which is, he thinks, the stable foundation for that part of the biological edifice that now requires building. Biologically he is perhaps nearest Weismann, but he believes that the psychical is the most important biological factor; he will not hear of the transmission of somatic modifications, but he believes that the transmigration of souls is almost self-evident. In discussing Lamarckism he points out that it has two sides; on the one hand, it is an erroneous theory of passive transformation conditioned by external stimulus; on the other hand, it is a true theory of the subjective response of a creative agent. He develops this second idea—which he calls by the extraordinary name of "Eulamarckism."

Prof. Schneider is a neo-vitalist who has the courage to say out and out that he believes in a specific vital energy, in a living substance. There are some who deny this, and maintain that life may be described as a succession of fermentations and the like, but this view ignores the phenomena of regulation and correlation, not to speak of memory and the power of profiting by experience. There are others who deny a living substance, and refer regulation and mental processes to an immaterial principle or agent, which deals directively with metabolism, though it is not of it. Schneider does not sympathise with either of these positions; he supposes a special vital substance, the vehicle of the specific vital energy, just as the ether is the medium for radiant energy. But this vital substance is not a particular kind of matter; it consists of psychical substances residing in the structural units of the organism. The relation between Psyche and Physis is illustrated by the mutual relations in thermochemical processes. The physical processes in the plasma, which are set going by stimuli, correspond to the chemical processes; the associated psychical energy corresponds to heat. On the one hand there is molecular movement, on the other there is cell-sensation. Life depends on the sensations of cells, as heat on the movements of molecules. As temperature is the intensity-factor of heat, structure is the intensity-factor of vitality, the measure of vital potency.

In a short notice it would not be for edification to try to expound the author's views on the four-dimensional character of consciousness or the law of the conservation of the psyche, or his theory that the mysterious process of assimilation represents a particular kind of gravitation, and that the psychical analogue of the force of cohesion is the entelechy or soul—the formative principle of the organism.

Prof. Schneider believes strongly in mutation, but the essential factor in species-formation is "*Descension*"—which means a thorough-going change in organisation, such as getting a notochord or gill-clefts. To study descensions is at present the most urgent task of ætiologists. What brings about a "Descension"? It is a step in the "entelechialen (synthetischen) Umprägung" which seems to be the most characteristic secret of the organism.

J. A. T.

OUR BOOK SHELF.

Arithmétique graphique. Les Espaces arithmétiques; leurs Transformations. By Gabriel Arnoux. Pp. xii+84. (Paris: Gauthier-Villars, 1908.) Price 3 francs.

THE title of this little work does not indicate, as the English reader might expect, another addition to the ever-growing list of treatises upon geometrical methods of calculation or the graphical solution of ordinary problems. It might rather be described as an essay upon the geometrical interpretation of the theory of numbers.

The author has attempted a systematic exposition of what may be called the geometry of abacs and magic squares. By an *arithmetical space* he understands the set of all points (in a geometrical space of any number of dimensions) the coordinates of which are integral, and he has worked out the properties of such point-systems. Many theorems true for con-

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tinuous space hold unchanged for such a discontinuous space. Some operations, however, such as rotation and transformation of coordinates to new axes inclined to the original ones, are possible only in certain cases. The study of the conditions under which such operations are possible, and of the effect of these operations when the conditions are satisfied, forms the main drift of the book.

The most interesting chapters are those which deal with what the author calls *modular* spaces. A modular plane space of modulus m is a square of m^2 points, a point (a, b) of this square representing all points $(a+pm, b+qm)$ of the unlimited arithmetical space, p, q being arbitrary integers. Geometrical properties of the complete unlimited space yield corresponding properties of the fundamental modular square, the coordinates of the original points being replaced by their *congruent* numbers of modulus m.

Transformations of coordinates in such modular spaces lead to the construction of magic squares and abacs.

Graphical methods are given for the solution of diophantine equations, and the last chapter deals with a number of problems, among them the following, originally proposed by Euler; from each of six different regiments six officers of different rank are taken. The problem is to arrange them in a solid square so that in each row and in each column there shall not be two officers of the same rank or of the same regiment. This problem, which was shown to be insoluble by MM. G. and H. Tarry in the case of thirty-six officers, is soluble when there are sixteen, and the reasons for this are here discussed.

Strangely enough, this branch of mathematics, although it might well be classed amongst the purest of the pure, is not without its industrial applications, notably in the weaving of tissues and fabrics.

Altogether, we commend M. Arnoux's book to those interested in the mathematical curiosities of the theory of numbers.

L. N. G. FILON.

Contributions to the Study of the Early Development and Imbedding of the Human Ovum. By Dr. T. H. Bryce, Dr. J. H. Teacher, and J. M. M. Kerr. Pp. viii+93; 10 plates. (Glasgow: J. MacLehose and Sons, 1908.) Price 12*s*. 6*d*. net.

It will be a glad day for the science of embryology when all the details of the sequence of the development of man are described from successive stages of the human ovum and embryo. The chick has, to a great measure, passed from the position that once it occupied, and even the lower mammals cannot be taken as substitutes for human material, when human development is to be rightly studied. Much that is confusing in embryology to-day is the outcome of reading whole pages of the embryonic life-histories of other creatures into the early chapters of human development.

In certain special directions the primates form a group distinguished developmentally from other mammals, and man and the anthropoids differ in some details from the other primates. Our knowledge of the development of man will, therefore, not be ideal until all our stages are accurately described from purely human material. Towards the attaining of this ideal, the description of the Teacher-Bryce ovum materially helps; at the same time, it probably holds out a guarantee for the further extension of our knowledge of the earliest stages of human development, for the material so carefully treated in this case is material that is often neglected.

The Teacher-Bryce ovum is the earliest human ovum yet described—its age is computed at thirteen to fourteen days—and, owing to the care taken in ascertaining the details of its history, this computation may be taken as final.

It is younger, by probably a day, than the well-known ovum of Hubert Peters, described in 1899, although that ovum was originally considered to be no more than three to four days old.

Great care and a wealth of detail have been used in making the account of this ovum as complete as possible, and in order to render the material of more value, a table of all the recorded early human ova has been incorporated for comparative purposes.

The volume in which this ovum is described also contains the description of an early ovarian pregnancy, and this—like the uterine ovum—is the earliest stage that has yet been described.

It is but natural that, in dealing with such material, many new details should come to light, and all the many points of novelty receive very ample discussion and illustration. The whole technic of the work, and especially the many fine illustrations, mark a distinct advance on the ordinary run of English scientific publications, and towards this perfection the authors have to thank the Carnegie Trust for assistance. Dr. Bryce has already demonstrated his specimens at the meetings of scientific societies, and the general features of his early ovum are now well known to embryologists, but the book in which he describes it contains, apart from the mere description, a vast amount of well-assorted detail, got together and presented in most workmanlike fashion.

Graphic Algebra. By Dr. Arthur Schultze. Pp. viii+93. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1908.) Price 4*s*. 6*d*.

In this text-book the author first gives examples of plotting from physical and statistical data, and the graphing of simple functions of one and two variables. He then proceeds to the main purpose of the book, which is that of solving algebraical equations by the use of squared paper and a few standard curves. Equations up to the fourth degree are fully dealt with, and, in order to facilitate the work, a method is cleverly developed in which the direct graph is replaced by two loci of a simpler nature, the intersections of which give the required roots. Thus a quadratic equation is solved by reading off the intersection of a standard parabola and a straight line; the same parabola is used for all quadratics, and it is only the scale and the position of the line which vary. Instead of the parabola, a rectangular hyperbola may be used. Cubics are dealt with by means of the curve $y=x^3$ and a suitable straight line. Biquadratic equations are solved by the intersection of a circle and the standard parabola or standard hyperbola. In all cases it is shown how to find the imaginary or complex roots, if such exist.

The whole subject is treated in a very concise and interesting manner, and the reader should become fully conversant with the principles of graphing and the nature of algebraical equations. But the special methods, however ingenious, must be regarded rather in the nature of mathematical exercises than as having any very useful practical applications, for such equations occur so seldom outside text-books that when an actual case does arise, simple direct methods of solution are usually to be preferred. This admirable manual concludes with an appendix containing some "statistical data suitable for graphic representation," a short table of squares, cubes, square roots, and reciprocals of numbers, and a collection of answers to the many exercises which are provided throughout the text.

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